3.G.3 c. Overcurrent (46 CFR 111.05-37). In the case of over current devices that are heat dependent, such as a fuse or the thermal trip on a circuit breaker, temperature is important, as it relates to the time it takes to remove an undesirable condition (overload). A device in a temperature lower than it is rated for will be slightly slower to trip on overload. If the temperature is higher, it will trip more quickly. In specific instances, either of these could be the undesired event. In the fault current range, the time effect is negligible. It should also be noted that many of these mass produced devices do not perform uniformly.

4. Power Supply (46 CFR 111.10).

a. Capacity. Determining the number and size of generating sets needed for a vessel requires a careful analysis of the normal and maximum demands during various phases of operation, including at sea, maneuvering, and in port.

Also, any special or unique operational considerations should be addressed. It is the intent of the regulations to ensure all normal "ship's service" loads can be kept energized with the largest generator out of operation, and without use of the emergency generator. It is not the intent of the regulations to ensure that the vessel can continue to perform an industrial function, such as drilling or dredging, with a generator in reserve. Ship's service loads are defined in detail in 46 CFR 111.10-1.

Of special note is that refrigerated container loads are considered "ship's service" loads. This is so cargo preservation attempts will not require sacrificing the more traditional ship's service loads should an operating generator fail. Other arrangements, such as a separate generating system, or a reefer load-shedding/load management system can provide an equivalent level of safety.

Procedures for conducting a thorough load analysis, typical ship's service operating load factors, and a sample load analysis are contained in section 3.B.2.b(3)(d) of this chapter.

b. Main Engine Dependent Generators. The most commonly used prime movers for ship's service generators are dedicated diesel engines and steam turbines supplied by the propulsion boiler(s). However, due to escalating fuel costs, owners and designers are always looking for less expensive means to provide the necessary electric power. Shaft-driven generators, power take-off (PTO) generators, and waste heat driven turbogenerators offer flexibility and greater efficiency. In many cases, however, they are constrained to certain main engine speed and power operating ranges.

SOLAS states that the arrangements of the ship's main source of power shall be such that the ships service loads can be maintained regardless of the speed and direction of the main propelling engines or shafting. This is reflected in 46 CFR 111.10-4(b) and (c), which require that ship's service electrical power be provided continuously, regardless of propulsion shaft speed or direction. In the worst case, this means that an "engine stop" or "full astern" command on the bridge propulsion control lever while operating at the

3.G.4 b. (cont'd) minimum engine speed for full generator output must not result in interruption of ship's service power.

Generators may be mechanically driven by the main diesel engine directly by the line shaft, by means of a PTO from the engine, or through intermediate gearing. Because changes in main engine speed would normally result in changes in the generator speed (and, therefore, frequency), a variety of methods has been developed to maintain constant frequency. These include the operation of the main diesel engine at a constant speed with the pitch of a controllable pitch propeller independently controlled, the use of a constant speed gear drive to give a constant output shaft speed over a range of input shaft speeds, and the application of a static rectifier-inverter combination to transform variable frequency AC to constant frequency AC.

Waste heat energy from the main diesel engine can be recovered in an exhaust gas boiler to generate low pressure steam to drive a turbogenerator. This generator can be operated only when sufficient exhaust heat is available, so start-up and shutdown are usually manually initiated. To optimize the recovery of exhaust heat, a generator loading control system may be used with load-sharing and speed (governor) controls to maximize turbogenerator loading when operating in parallel with other generators. Any main engine or waste heat driven generator which is not capable of providing power under all operating conditions, including maneuvering and in port, cannot be counted towards the required ship's service generating capacity. Such a generator may however, be provided as a supplemental generator. In any case, one of the required generators must be independent of the main propelling engines and shafting.

Where a supplemental generator is used to supply power for ship's service loads, it must provide a continuous and uninterrupted source of power under normal operational conditions, including any speed change or throttle movement. Automatic start-up of and load transfer to a standby diesel generator must be provided to prevent power interruptions when conditions are such that the supplemental generator is unable to supply the ship's service load. A finite time is required to start, synchronize, and parallel a standby diesel generator, and the main engine-driven generator must remain on line until the standby generator has assumed the load. A signal from the propulsion control and a shaft speed signal may be used to automatically initiate connection of the standby generator. Once a throttle change has been made, the time required for the main engine to slow to the point where the generator cannot supply the ship's service load depends on the original speed as well as the coast-down characteristics of the hull and propulsion plant. In many cases, the coast-down time for a two-stroke slow speed main diesel engine is long enough to allow the standby generator to assume the load without power interruption. If it is not, the disconnection of the shaft or PTO generator must be delayed. To prevent power interruptions from occurring, the speed of the main engine may be automatically held at or above the lower operating threshold for generator operation for approximately 10 seconds. This delay, automatically activated only when needed, is considered to be comparable to the time necessary for crew response to maneuvering bells in a manned engineroom. Since the typical main engine dependent generator installation employs